Auditory processing disorder (APD) is diagnosed on the basis of listening difficulties and poor performance on tests of auditory processing despite a normal audiogram. There is debate over whether APD is a separate diagnostic entity in its own right with a distinctive psychometric profile, or whether it is a reflection of a more general learning disability.

What this study adds

- Children with a diagnosis of APD have high levels of attentional, reading and language difficulties. A substantial minority may also have autistic features. These children are therefore likely to benefit from evaluation by a multidisciplinary team.
the Random Gap Detection Test\(^2\)). This method of APD diagnosis is typical of clinical identification of APD in the USA and UK.\(^2,3\)

**Dyslexia group**

Nineteen children were recruited either from local schools or as participants from previous studies; all had a diagnosis of dyslexia by an educational psychologist. For inclusion in the study, dyslexia was defined as a reading or spelling test standard score below 85 and a non-verbal IQ greater or equal to 80 (see Assessments). All participants had normal hearing as indicated by pure-tone audiometric screening test (at 20 dB HL for 250 Hz to 8 kHz\(^13\)). Parental consent for participation was obtained in accordance with University and NHS ethics requirements.

**Assessments**

Testing was carried out in a quiet room by a trained examiner.

**Psychometric tests**

- Wechsler Abbreviated Scale of Intelligence matrix reasoning and block design subtests.\(^14\) Non-verbal IQ is calculated as a composite of matrix reasoning and block design subtests.
- Test for Reception of Grammar, electronic version (TROG-E).\(^15\) The TROG-E is a test of receptive language that assesses comprehension of grammatical contrasts marked by inflections, function words and word order.
- Expression, Reception and Recall of Narrative Instrument (ERRNI).\(^16\) ERRNI assesses the ability to relate a pictured story, and recall and answer questions about it after a short interval. Children’s performance is compared with UK norms according to how much relevant story content is provided, sentence length, comprehension and recall of the story.
- Sentence Repetition and Repetition of Non-sense Words from NEPSY.\(^17\) These tests, which are sensitive indicators of language impairment,\(^18\) tap short term memory.
- Test of Word Reading Efficiency (TOWRE).\(^19\) The TOWRE assesses the ability to read real words and non-words under time pressure.
- The OSCCI spelling test was developed within our research group as a quick and efficient test of spelling ability. Children are asked to write a list of regular and irregular words within a 2 min time limit. Performance norms are based on 58 typically developing British school children aged 6–15 using the regression of score on age to convert to age-adjusted standard scores.
- SCAN-C\(^10\) and SCAN-A.\(^9\)
- The SCAN is a US-produced standardised test of auditory processing, and is the most commonly used instrument for diagnosis of APD.\(^2,3\) (Note that current recommendations are that the SCAN or similar test form part of a comprehensive test battery for APD diagnosis. APD diagnosis is not recommended on the basis of the SCAN alone.\(^20\))
- Test takers repeat monaurally presented single word stimuli that have been acoustically filtered to reduce intelligibility or are presented against a background of multitalker babble, as well as single words and sentences that are presented dichotically. Stimuli are recorded on compact disc and presented via headphones. Accuracy of responses is scored and compared with performance norms to provide standard scores.
- The child version, the SCAN-C, is for use with children aged 5–11, while the SCAN-A is for those aged 12 and above.

**Parental questionnaires**

- Children’s Communication Checklist—2 (CCC-2).\(^21\) The CCC-2 is a parent-completed questionnaire that can be used to screen for language impairment, to identify pragmatic impairments in children with communication problems and to identify children as candidates for further assessment for an autistic spectrum disorder. The CCC-2 provides norm-referenced scores in 10 linguistic and pragmatic subscales as well as providing an overall index of communicative competence and a social interaction deviance score, which can be used to identify children with a communicative profile characteristic of autism.
- Strengths and Difficulties Questionnaire (SDQ).\(^22\) The SDQ is a brief screening questionnaire for behaviour problems in children. The 25 items are divided into five subscales; emotional symptoms, conduct problems, hyperactivity/inattention, peer problems and prosocial behaviour. The SDQ also provides an overall index of behaviour problems.
- Children’s Auditory Performance Scale (CHAPS).\(^23\) Respondents rate a child’s ability to hear and understand in a range of conditions including noise, multiple inputs and quiet. The CHAPS provides scores for each condition as well as an overall auditory performance index. Recommended performance cut-off scores for referral for APD assessment based on normative performance data from children with suspected APD and controls are reported in the CHAPS manual.
- Childhood Asperger Syndrome Test (CAST).\(^24\) The CAST is a screening test for autistic spectrum features in children aged 4–11, which was completed by parents of a subset of cases 6–8 months after the rest of the battery. Parents respond with a yes or no to statements such as ‘Does s/he tend to take things literally?’ or ‘Is her social behaviour very one-sided and always on his/her own terms?’ The number of ‘yes’ answers is then totalled.

**RESULTS**

APD and dyslexia groups did not differ in age (means of 10.4 years, SD 2.5 and 10.1 years, SD 1.6 respectively, t(42)=−0.48, p>0.05). There was a higher proportion of males in the dyslexia group (17/19 cases) than in the APD group (15/25 cases), Fisher p=0.04. The two groups were not significantly different in non-verbal IQ (M=98.7, SD 14.8 and M=102.2, SD 11.4, respectively for APD and dyslexia groups, t(42)=0.86, p>0.05).

**Comorbid conditions**

Rates of dyslexia, SLI as well as attentional and auditory processing problems were examined in the APD and dyslexia groups. Dyslexia criteria were as used for dyslexia group selection. SLI was defined as a non-verbal IQ of 80 or better and performance on two or more out of six language tests (TROG, NEPSY sentence repetition, NEPSY non-word repetition, ERRNI storytelling, ERRNI MLU, ERRNI story comprehension) below −1 SD. Around half (15 of 25, 52%) of APD children would also fit a diagnosis of either SLI, dyslexia or both. A relatively high proportion of children in the dyslexia group would also fit a diagnosis of SLI (11 of 19, 58%). The proportion of children who fit a diagnosis of SLI was not statistically significantly different between the APD group and the dyslexia group (Fisher p=0.36). Hyperactivity/inattention was identified using recommended cut-off scores for the parent-completed SDQ and

**“Original article”**

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The ‘literacy composite’ is the average of the standard scores of three literacy tests (OSCCI spelling, TOWRE word and non-word reading). The mean composite scores are shown in table 1. Unsurprisingly, as the group was selected on the basis of poor literacy skills, the dyslexic group did significantly worse on the literacy composite, although both groups’ average literacy score was below −1 SD. Groups did not differ significantly on language composite or SCAN composite score.

For parent-completed questionnaires, the APD group scored worse on the CHAPS listening behaviours questionnaire. There was no difference in overall CCC-2 general communication composite (GCC) score. An ANOVA was carried out to compare the average score on each CCC-2 subscale between groups. Both groups scored similarly low on speech, syntax and semantics (an average subscale score is 10 with SD 3, shown in figure 1 by a dotted line). After adjusting for multiple comparisons (p<0.005), there were no significant differences between groups on any subscale. ‘Use of context,’ ‘non-verbal,’ ‘social’ and ‘interests’ subscales were approaching significance (p=0.02–0.06). These subscales are associated with autistic spectrum disorders. Overall, both structural language and pragmatic problems were a feature of children with suspected APD.

Discrepancy between parental report and standardised tests
During evaluation of individual test results, it was noticed that parents of APD participants tended to rate their children less well on the CCC-2 than their child’s performance on standardised language tests would suggest. This tendency was examined statistically. GCCs from the CCC-2 were converted to standard scores for comparison with the standardised language composite to have a mean of 100 and a SD of 15. The magnitude of the discrepancy between parental communication checklist and standardised language test was then calculated as the language composite minus the standardised total CCC-2 score (DISCREP). There was a group difference in the magnitude of the average discrepancy score, with the APD group significantly higher (APD M=24.32, SD 11.99, dyslexia M=16.88, SD 11.29, t(41)=−2.10 p<0.05, r=0.31).

One possibility that may explain the discrepancy between parent report of poor communicative competence and relatively good standardised test performance is that while these children may have a relatively good structural language, they have difficulties using language appropriately and effectively in more demanding communicative situations. CCC-2
subcales on which group differences were approaching significance were associated with autistic spectrum disorders, with the APD group being rated worse on these pragmatic subcales (though non-significant after correction for multiple comparisons).

This raised the question of some children with a diagnosis of APD having unidentified autism spectrum disorders, leading us to obtain approval from the NHS Ethics Committee to obtain additional information from the CAST, 6–8 months after the initial study. Valid CAST questionnaires were received from the parents of 12 dyslexia and 18 APD participants. Average CAST raw scores were significantly higher in the APD group than in the dyslexia group (11.1 SD 5.5 vs 5.2 SD 2.5, t(28)=−3.4, p<0.01, r=0.54). The recommended cut-off score for identification of possible clinical cases is 15. Applying this criterion yielded six cases within the APD group (33%) and no cases within the dyslexia group. This difference was marginally non-significant (Fisher p=0.06, two-sided). There was also no correlation between DISCREP and CAST raw score (r=0.27, NS).

DISCUSSION

We were interested in whether children diagnosed as having APD have a distinctive pattern of psychometric performance, and whether the pattern differed from that of children with dyslexia. Around half of the children diagnosed as having APD would fit a diagnosis of dyslexia or SLI or both. Conversely, the dyslexia group scored similarly to the APD group on the SCAN test of auditory processing. A high prevalence of attention/hyperactivity problems was also a feature of both groups. While there was a trend for the APD group to do worse than the dyslexia group on all the behavioural measures, the only significant difference in performance between groups was on literacy measures, where the dyslexia group, who had been selected on this basis, did worse. Average literacy scores for the APD group were also poor. In terms of severity of attentional, reading, language and auditory processing skills, the difference between APD and dyslexia children is quantitative rather than qualitative, with APD diagnosed children tending to have more severe problems.

One characteristic that did distinguish between these two groups was that in the APD group, there was an unusual discrepancy (DISCREP) between parental ratings of poor communicative competence or listening behaviours and standardised test performance (standardised language tests and the CCC-2, and the CHAPS and the SCAN). We considered the possibility that this might indicate that children who receive a diagnosis of APD have elevated levels of autistic features, since pragmatic difficulties are often not detected on formal psycho

In summary, children diagnosed as having APD did not differ qualitatively from those with dyslexia in their performance on psychometric tests of IQ, auditory processing, language or literacy, though there was a tendency for children with APD to perform worse across all measures. In contrast to those with dyslexia, children with APD showed a discrepancy between parent report of poor communicative competence and relatively good performance on standardised language tests. We suggest that pragmatic problems associated with autistic spectrum disorder, to which standardised tests are largely insensitive, may partially explain this discrepancy. The most striking finding was that a third of children with an APD diagnosis fell within the clinical range on a screening questionnaire for Asperger syndrome, though ASD had not been formally recognised for most of these cases. This finding deserves further investigation with a larger sample of children with suspected APD. It may be useful to screen children referred to APD clinics for ‘listening difficulties’ for communication problems associated with unrecognised ASD. Effective management might then centre on remediating these children’s pragmatic difficulties. Many children with APD do have demonstrable learning problems, though it is unclear to what extent their reported listening problems are due to actual difficulties with auditory processing, language difficulties or ASD.

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